OSC014 - ALGEBRA-BASED PHYSICS I (WITH LABS)

4-5 Semester Hours

Co-requisites: College Algebra and Pre-calculus.

Related TAGs: Biology, Chemistry, Civil/Construction Engineering Technology, Electrical Engineering Technology, Mechanical Engineering Technology

Required Components include:

- I. **Experiment**
- II. **Kinematics**
- III. **Dynamics**
- IV. **Conservation Laws**

Optional Components include:

- V. **Oscillations and Waves**
- VI. **Fluids**
- VII. **Heat & Thermodynamics**

In order for a course to be approved for OSC0 014- Algebra Based Physics I (with labs), all of the following must be met:

1) All "Required Component" student learning outcomes (SLOs) 1-4 must be met and **<u>at least one out of the three</u>** "Optional Component" SLO's 5-7 **<u>must be met</u>**.
2) All student learning outcomes (SLOs) embedded within a "Required Component" area are required to meet the entirety of the core component area. This is also true for the "Optional Component" SLO's. All SLO's embedded within the optional component are required to meet the entirety of the optional component area however, this is only true when an optional component area is selected by an institution.

<u>Required Components</u>

1. **Experiment**:
   The successful Algebra-Based Physics I (with lab) student will be able to:

   1a. Collect data, assess its validity, and interpret its physical meaning for experiments that relate to the topics included in the required learning outcomes in required components 1-4 in OSC 014.

   1b. Meet the guidelines for the Natural Sciences Laboratory Requirement for the Ohio Transfer 36, found at the following link here.

<u>Sample tasks</u>

- Demonstrate an understanding of the validity and meaning of data by writing lab reports with data-supported conclusions.

- Represent and analyze data in various forms (e.g., graphs and tables), as well as recognize trends and patterns in data accounting for scatter and outliers.
- Implement and design basic experimental procedures including the choice, variation, and control of variables, as well as recognize the existence of uncertainty and an estimate of the precision of the measurements.
- Analyze data through the use of various mathematical approaches including vector manipulation and analysis, trigonometry, and algebra.
- Validate physics models and principles through collection of real physical data obtained by hands-on measurement.
- Recognize group work is a preferred environment through teamwork for data acquisition, collaborative data analysis, and shared report-writing procedures.

2. **Kinematics**:
The successful Algebra-Based Physics I (with lab) student will be able to:

2a. Make accurate verbal, graphical, and mathematical descriptions of translational and rotational motion in one and two dimensions.
2b. Use algebra and graphical methods to link displacement, velocity, and acceleration.
2c. Solve 1D kinematic problems with constant linear and angular acceleration.
2d. Solve 2D projectile motion problems with start and end points at different heights.
2e. Relate the motion of two objects relative to each other.

Sample tasks

- Find the final speed of a particle dropped from rest at a given height.
- Calculate the launch speed required to put a basketball through a hoop.
- Sketch graphs of speed versus time and velocity versus time for an object that is thrown upwards and returns to the starting point.
- Sketch graphs of position versus time for the same motion using two sets of coordinate axes (different origins and/or positive directions).
- Determine the distance traveled by a rolling disk from angular acceleration, initial speed and elapsed time.
- Calculate the number of revolutions made by a spinning wheel slowing to a stop at a constant rate.
- Given a graph of velocity vs. time for a particle in moving in one dimension, interpret the physical meanings of the graph's slope and intercept, then qualitatively sketch the position vs time or acceleration vs time graphs for the same interval.
- Determine the horizontal distance for a soccer ball kicked from the ground to a flat roof, given the height of the roof and the initial velocity (magnitude and direction).
- Explain the difference between average velocity and average speed, using a concrete example of an object moving in one or two dimensions.

3. **Dynamics**:
The successful Algebra-Based Physics I (with lab) student will be able to:

3a. Use Newton’s laws of motion (1st, 2nd, and 3rd) to explain or predict the motion of translating and rotating objects.

Sample tasks

- Create a complete and accurate free-body diagram for sign suspended at rest by two cables.
- Determine the acceleration for an Atwood's machine.
- Determine the minimum coefficient of static friction needed to prevent a car from slipping as it travels around a circular track at constant speed.
- Calculate the internal forces arising among 3 blocks of different masses blocks pushed by a constant horizontal force at a constant speed given the coefficient of kinetic friction.
- Determine the location of a fulcrum to balance 2 different masses on a rigid uniform plank which also has mass.
- For a cord wound around a circular object and a mass tied to the cord, predict how the angular acceleration of a uniform disk differs from a uniform hoop when the mass is released.
- Analyze a system of three wooden blocks in contact while being pushed across a smooth level table, making use of free body diagrams and Newton's laws of motion.
- Draw free-body diagrams of an object on the floor of a rising elevator based on a velocity-time graph of the elevator's motion.
- Determine the amount of frictional force that acts on an object at rest while it is being pulled, but before it starts to slide.
- Explain why objects on the seat of a car will slide forward when the car abruptly slows down.
- Draw a free body diagram of a falling object as it approaches terminal speed.

4. **Conservation Laws**:
The successful Algebra-Based Physics I (with lab) student will be able to:

4a. Explain or predict the motion of translating and/or rotating objects using conservation of energy.
4b. Explain or predict the motion of translating and/or rotation of objects in 1D using the conservation of momentum.
4c. Explain or predict the outcome of collisions.
4d. Determine the center of mass of extended objects.
4e. Determine the moment of inertia of rigidly connected masses.
4f. Use the parallel axis theorem in the solution of problems of extended objects of simple symmetries rotating about an axis that is not through their center of mass.

Sample tasks

- Compare the speeds of a roller-coaster at various points of different elevations along its track, assuming that friction and air resistances are negligible.
- Explain why rolling objects of the same mass and radius, but different shapes, do not all reach the bottom of a ramp at the same time.
- Calculate the height necessary for a disk rolling down an incline to achieve the same speed at the bottom of the incline as a sphere achieves rolling down the same incline at a given height.
- Determine the outcome of a one-dimensional totally inelastic collision given the masses

and the initial velocities.
- Decide whether or not a one-dimensional collision is totally elastic given the initial speeds of, the masses, and the final speed of one of the objects.
- Predict whether a rotating platform will speed up or slow down as a passenger walks inward or outward along the platform's radius.

Optional Components

5. **Oscillations and Waves**:
The successful Algebra-Based Physics I (with lab) student will be able to:

5a. Explain or predict motion of objects in simple harmonic motion.
5b. Explain or predict mechanical wave phenomena in terms of frequency, wavelength, wave speed, and simple harmonic motion.
5c. Use superposition in solving problems with interference of two waves.
5d. Describe standing wave patterns and how their confinement determines the wavelength allowed.
5e. Describe and predict the addition of two waves of similar but not identical frequency aka the beating of waves.
5f. Solve problems where the frequency of a sound detected is affected by the motion of the source and/or the receiver relative to the medium (Doppler Effect).

Sample tasks

- Describe the motion (position, velocity, acceleration) of a simple pendulum in regard to length and frequency.
- Describe the motion (position, velocity, acceleration) of a mass connected to a spring (horizontal and vertical).
- Describe the motion (position, velocity, acceleration) of a mass connected to two or more springs (horizontal and vertical).
- Describe the motion (position, velocity, acceleration) of a physical pendulum.
- Describe the motion of the above systems via conservation of energy
- Explain how an understanding of transverse and longitudinal earthquake waves helps us understand the makeup of the earth specifically that there is a solid core surrounded by a liquid core.
- Calculate the observed frequency for a moving observer given the speed of the observer towards or away from the sound source and the frequency of the sound produced by the source.
- Compare the maximum speed of a traveling wave along a string to the maximum speed of a point on the string.
- Find the resonant frequencies of the standing waves for an open pipe and a closed pipe of the same length, given the speed of sound in air.

6. **Fluids**:
The successful Algebra-Based Physics I (with lab) student will be able to:

6a. Describe how the pressure in a fluid varies as a function of depth interns of the pressure relative to the surface of the fluid and the absolute pressure in the fluid.
6b. Predict whether and object will sink or float in a fluid.
6c. Predict the variation in velocity and pressure as an incompressible fluid flows though pipes of varying diameter and height.
6d. Predict the apparent weight of objects partially or fully immersed in a fluid.
6e. Explain the physics underlying hydraulic lifts.

Sample tasks

- Determine the force exerted by the atmosphere on the palm of a hand.
- Explain why the pressure on a swimmer's eardrum increases as the swimmer moves downward.
- Predict the maximum load a raft can support without sinking in water.
- Predict the velocities of a fluid at several points along a pipe with varying diameter.
- Calculate the pressure required to push a fluid through a pipe from a lower position to an open storage tank on top of a hill.
- Determine the make-up up of a two-component system from the apparent weight in two different fluids.
- Calculate the wind speed necessary to lift the roof off a house.

7. **Heat & Thermodynamics**:
The successful Algebra-Based Physics I (with lab) student will be able to:

7a. Describe the effect of heat on the properties of materials.
7b. Describe/predict the transfer of energy between a system and its environment using the first law of thermodynamics.
7c. Describe an ideal gas in terms of volume, pressure, temperature, and number of moles.
7d. Relate macroscopic and microscopic properties of matter using the kinetic theory of gases.
7e. Predict the efficiency of a heat engine and its maximum efficiency.
7f. Describe and predict properties of gases using the ideal gas law.
7g. Describe properties of phases of matter (solid, liquid, and gas) and their transformations.
7h. Transfer of heat by conduction, convection, and radiation.
7i. Distinguish between reversible and irreversible processes.

Sample tasks

- Explain the difference between *temperature* and *heat*.
- Calculate the temperature rise required to make a copper rod expand by 1 mm.
- Given the coefficients of linear expansion of two metals, predict which way a bimetallic strip composed of those two metals will bend when heated.
- Given the initial temperature and pressure in an inflated tire, determine whether the tire's pressure will exceed its maximum safe level when heated to a specific temperature.
- Calculate the number of moles of gas at certain volume, pressure, and temperature.
- Calculate the heat required to bring a gallon of room-temperature water to boil.
- Describe molecular processes associated with the melting of a substance.

- Predict whether it would take more heat to melt the same mass of solid copper or water ice, if both are already at their melting points.
- Calculate the equilibrium state of two gases in two different compartments when the separating wall was removed.
- Calculate the work done by a gas as it undergoes thermal processes (e.g., isothermal expansion).
- Classify a given process as either reversible or irreversible, based on heat flow.
- Use the concepts of heat, work, and internal energy to describe the operation of a heat engine.
- Describe simple thermodynamic process in one or more graphs (*PV*, *PT*, and *VT*).
- Explain why the freezing point is lowered by adding a solute (e.g., salt).
- Calculate the radiated and absorbed heat of a human body and explain the difference.